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COMMISSIONER

MEMORANDUM

TO: Elaine Krueger, MPH
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FROM: Martha Steele, MPH

RE: Health Effects of Pentachlorophenol

DATE: May 1, 1984

Introduction

The toxicity of pentachlorophenol (PCP) is complicated by the presence of contaminants (dibenzodioxins and dibenzofurans) formed during its production (a two stage process involving the chlorination of phenol). The amount of contamination can vary considerably from batch to batch, and manufacturer to manufacturer (Buser and Bosshardt, 1976). In several studies, the toxicity of PCP was attributed to these contaminants (NRC, 1982).

PCP is primarily used in wood preservation, and has been limited to specific situations as a termiticide, such as direct application to termite infested wood structures that cannot be easily replaced. It can be applied directly by a brush or spray. Pre-construction dipping or pressurized treatment of lumber can also be performed.

In 1978, a Notice of Rebuttable Presumption Against Registration (RPAR) was issued for PCP. In 1981, EPA published Position Document 2/3 (PD 2/3) which discussed wood preservative pesticides, one of which was PCP. Position Document 4 is due to be completed in May 1984.

Human Evidence

PCP is an uncoupler of oxidative phosphorylation (a series of reactions essential to the synthesis of the energy supplying molecule, ATP). Acute symptoms of overexposure include an increased metabolic rate, respiratory difficulty, loss of appetite, and sweating (NRC, 1982).

PCP is readily absorbed through the skin. Prolonged exposure has resulted in acne and disorders of the nervous system and liver. Persons with impaired liver or kidney function are more susceptible to its effects (NIOSH, 1978).

In one group of ten workers involved in the production of PCP for 5-10 months, all had acne, and seven had severe bronchitis. All but one still had acne more than one year after exposure ended, and four still complained of bronchitis (Baader and Bauer, 1951). Exact exposures were not known.

In another incident, twenty infants became ill and two died when linens that were washed with a product containing the sodium salt of PCP came into contact with their skin (Armstrong et al., 1969).

Animal Evidence

The oral LD50 in rats for PCP is 146-175 mg/kg (Gaines, 1969).

Several experiments have been conducted in rats for a duration of ninety days. In one experiment, oral exposure of rats to 50 mg/kg/day of both technical and pure PCP produced pathological changes in the liver, which were more severe in those exposed to technical PCP (Kimbrough and Linder, 1975). In another study, rats showed increased liver and kidney weight at 3 mg/kg/day of technical PCP (Johnson et al., 1973). Rats exposed to a purified sample of PCP showed no adverse effects at the same dose.

PCP (unspecified purity) was fed to Wistar rats for a 90 day period. Female rats receiving 10 mg/kg/day showed a decreased growth rate, and male rats showed increased liver weights at 2.5 mg/kg/day. No PCP related effects were seen in rats fed 1.25 mg/kg/day (Knudson et al., 1974).

In an eight-month study, technical and pure PCP were administered to rats at 25 mg/kg/day (Goldstein et al., 1976). Liver changes were produced, but not with pure PCP. "Thus, the porphyrin and other major liver changes induced by technical PCP are apparently due to contaminants, probably the chlorinated dibenzo-p-dioxins, rather than PCP" (NRC, 1977, pp. 753).

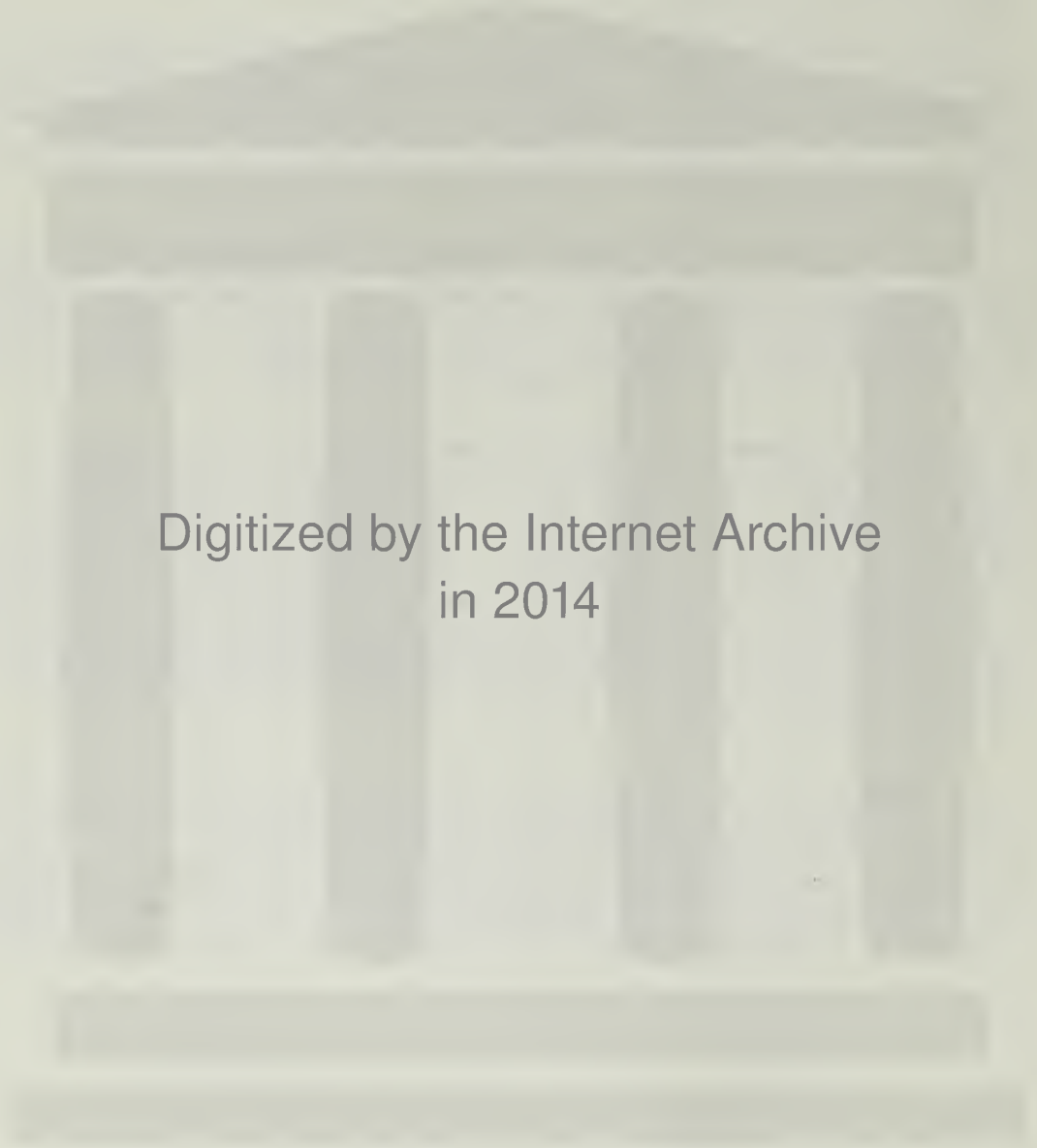
PCP (unspecified purity) has not been found to be carcinogenic in either rats or mice (NRC, 1982, IARC, 1982). A contaminant of technical PCP, hexachlorodibenzo-p-dioxin, has, however, been found to be carcinogenic in female rats and mice of both sexes in a 1980 study done by the National Cancer Institute (PD 2/3, 1981, pp. 345). Another contaminant, hexachlorobenzene, produced a greater incidence of hepatomas in both Syrian hamsters and Swiss mice (PD 2/3, 1981).

In rats, embryo- and fetotoxicity (fetal resorption, anomalies of the skull and vertebrae) were observed when 15 mg/kg or greater of pure or technical PCP were given on days 6-15 of gestation. The no-observed-effect-level for technical PCP was 5.8 mg/kg, but at 5 mg/kg (the lowest dose tested), pure PCP had delayed ossification of skull bones (Schwetz et al., 1974).

Another study in rats showed a decrease in neonatal survival and growth when 30 mg/kg of pure PCP was given before and during mating, and during the entire gestational period (Schwetz et al., 1978). A third study with CD rats given an oral dose of PCP at 60 mg/kg on days 8-13 resulted in a decrease in fetal weight (Larsen et al., 1975).

One study examined the reproductive effects in rats of purified dibenzo-p-dioxins (a contaminant of PCP) (Schwetz et al., 1973). Doses of 0.0001, 0.001, 0.01, and 0.1 mg/kg/day were administered on days 6-15 of gestation. Significant increases in fetal resorptions occurred at 0.01 and 0.1 mg/kg/day. The no-effect dose was considered 0.0001 mg/kg/day, as subcutaneous edema was observed at all other doses. At 0.1 mg/kg/day, cleft palate was signficantly increased over controls. Based on this study, EPA stated that dibenzo-p-dioxins are both fetotoxic and teratogenic at dose levels greater than 0.0001 mg/kg/day (PD 2/3, 1981, pp. 253).

In summary, PCP has been shown to cause liver changes and to be fetotoxic. In their risk assessment of fetotoxic effects, EPA stated a no-effect-level of 3 mg/kg/day, based on the 1978 Schwetz et al. study. The NRC, in deriving drinking water guidelines, based their acceptable daily intake level on a no-adverse-effect-level (for liver and kidney changes) of 3 mg/kg/day (from the Johnson et al. study, 1973) (NRC, 1977).



Exposure

Exposure to PCP in the home can occur. Many over-the-counter PCP products do not prohibit indoor use. The extent of exposure after indoor use depends on a variety of factors (ventilation rate, temperature, time spent indoors, etc.). However, according to PD 2/3, "penta volatilizes from treated wood for some time after treatment...and the available information does not preclude volatilization for the lifetime of the treated wood" (PD 2/3, 1981, pp. 267). Thus, prolonged exposure to PCP from indoor use can occur. EPA believed that use of PCP inside homes may result in continuous exposure to PCP at levels exceeding those found in commercial settings (PD 2/3, 1981, pp. 286).

Some exposure data have been compiled from indoor use. In California, incidents where occupants became ill after treating the interior of their homes with PCP occurred at levels ranging from 0.5 to 30 ug/m3 (PD 2/3, 1981). In an enclosed area where paint containing PCP was used, a concentration of 160 ug/m3 was measured (Gebefugl et al., 1976). Laboratory results indicated levels of 25-40 ug/m3 may be due to volatilization from pressure treated lumber (Thompson et al., 1979). PCP levels in a Kentucky log home where lumber was treated with PCP were 0.2 and 0.38 ug/m3.

Summary

PCP's major use is as a wood preservative. It can be applied by the homeowner, either indoors or outdoor, by painting or spraying. Thus, exposure via the inhalation or the dermal routes can occur easily. Furthermore, volatilization of PCP from treated wood inside homes can prolong exposure over a period of months or years.

Technical PCP, due to contaminants formed during production, is more toxic than pure PCP. However, both technical and pure PCP have been shown to be fetotoxic at doses as low as 5 mg/kg. In addition, there have been a number of reports of health effects in humans due to exposure to PCP, either in production of the substance, or after treating wood inside homes. Contaminants found in technical PCP have also produced carcinogenic effects in mice, rats, and hamsters.

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